Temporal variability of biodiversity in Arctic and subArctic marine benthic communities

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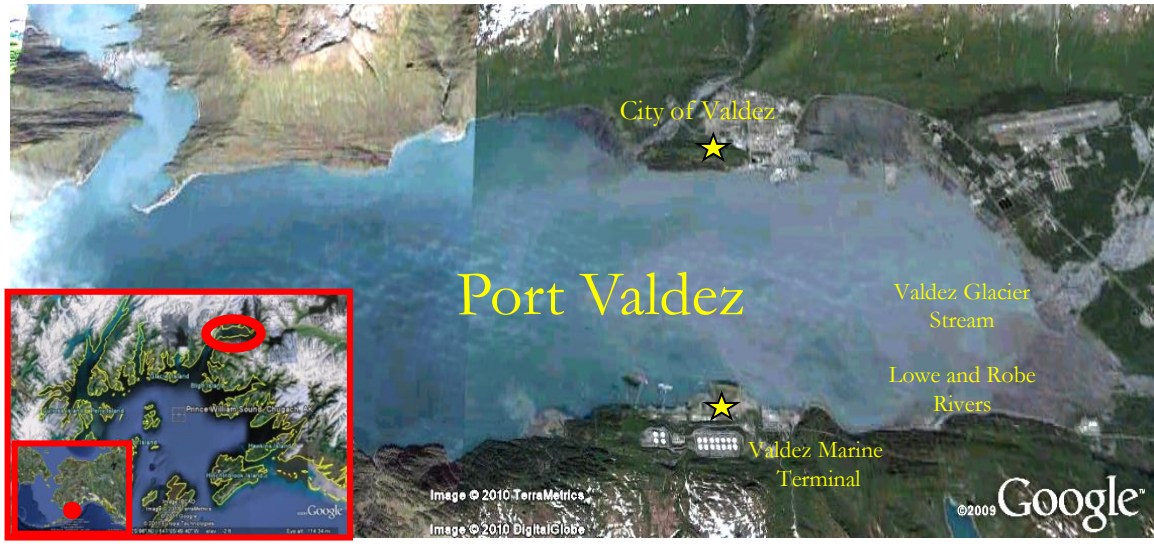
Questions about biodiversity

- Do we know enough about biodiversity?
  - We study distributions of dominants!
- Are spatially disperse stations across heterogenous habitats really describing biodiversity patterns?
- Do we know enough to draw inferences about marine invaders into the Arctic?

The Port Valdez Environmental Studies Program

PVESP: the first integrated multi-disciplinary environmental study in Alaska, 1971 to present.

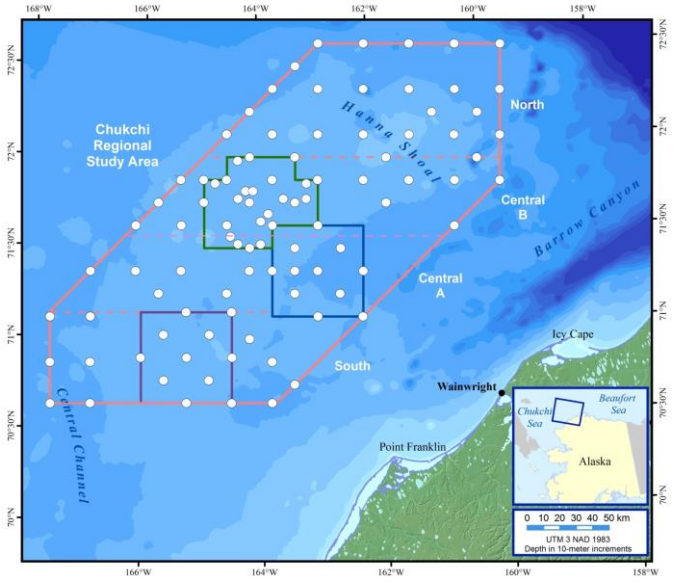
- Port Valdez is a glacial fjord, Prince William Sound, Alaska.
- Glacial sediments drive spatial gradients in biota.



The Chukchi Sea Environmental Studies Program

CSESP: An integrated multidisciplinary investigation of the northeastern Chukchi Sea ecosystem, 2008-2013.

- Three study areas were sampled in 2008-2013.
- A larger area encompassing Hanna Shoal was sampled 2011-2012.



Spatial patterns of biodiversity

- Environmental characteristics drive spatial patterns in biodiversity.

Rocky Shore | Cobble Beach | Mud and Pinnacle

Nucella spp. and red algae present.

Nucella spp. and red algae restricted.

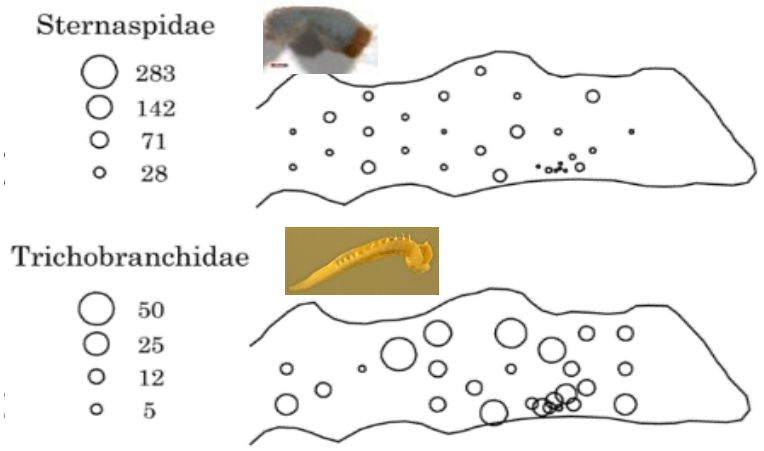
Freshwater/glacial Influences

High Salinity,
Lower glacial sediments

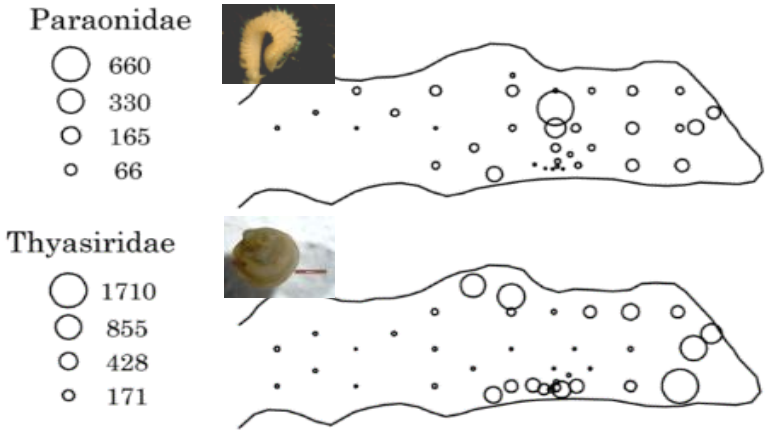
Low Salinity,
Higher glacial sediments

Spatial patterns of biodiversity

These animals less abundant in finer sediments.



These animals are abundant in fine sediments.



Muddy sediments.

Sedimentation rate

Silty sediments.

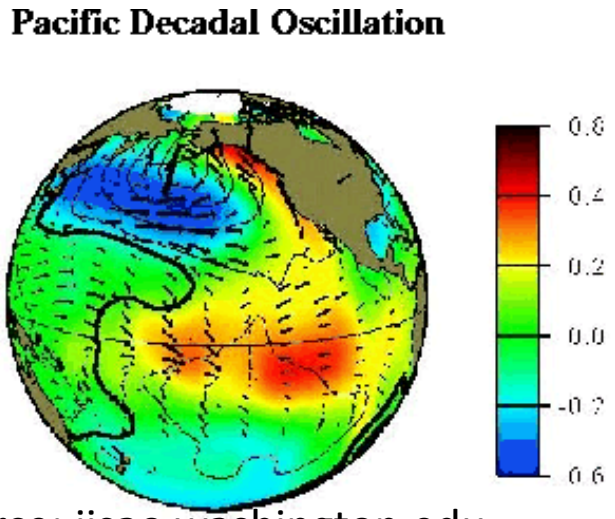
- Environmental covariates often confused with drivers!

Problems with biodiversity studies

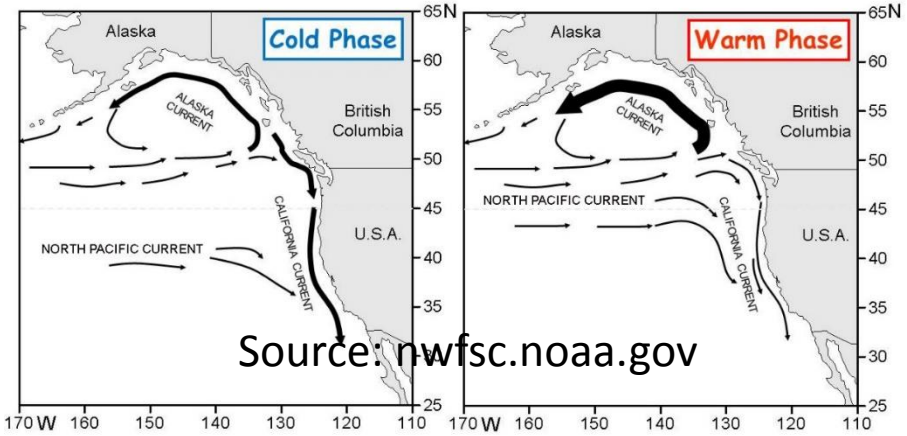
- Species are captured with varying probabilities specific to habitats.
- Species are so poorly known in Alaska that inferences are difficult to make about changes.
- Scales of natural change unknown!

Temporal drivers of diversity

- Water circulation patterns covarying with climate variations can influence benthic fauna observed diversity.
  - Port Valdez, Alaska.
  - San Francisco Bay, CA.



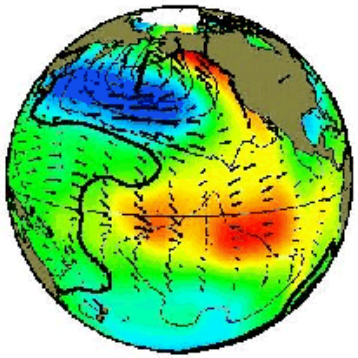
Source: jisao.washington.edu.

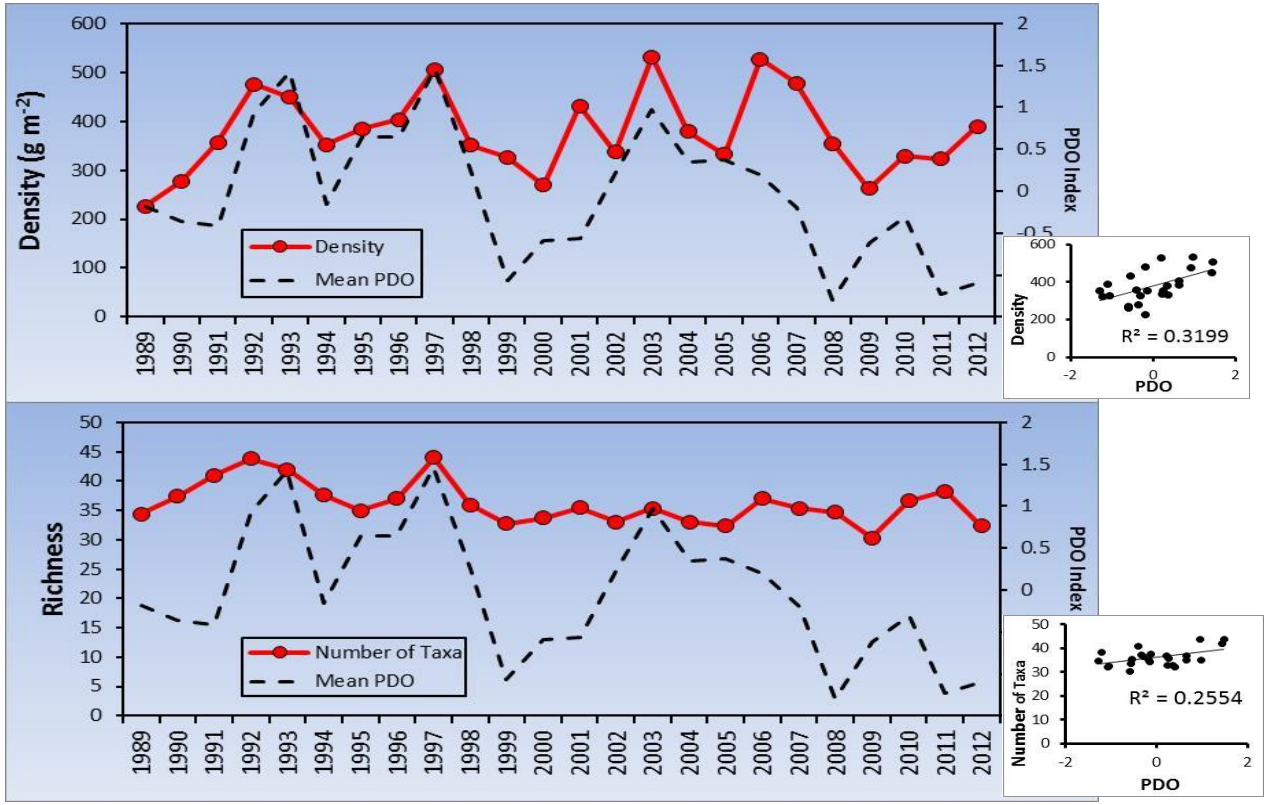


Source: nwfsc.noaa.gov

Temporal changes in subArctic biodiversity

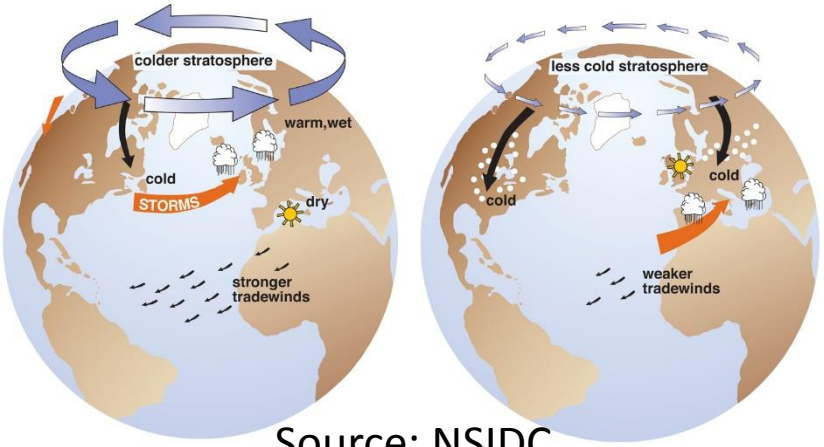
- Density and richness in Port Valdez moderately to strongly correlated with the PDO.



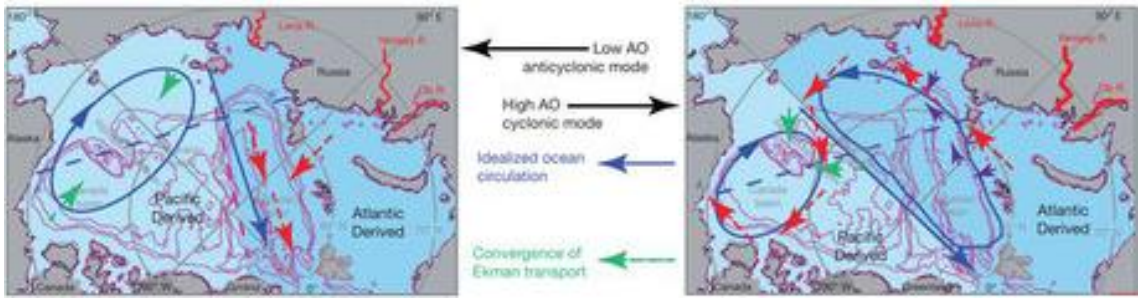


The Arctic Oscillation

- Higher sea level pressure in the Arctic Ocean (neg. AO phase) results in stronger Beaufort Gyre.



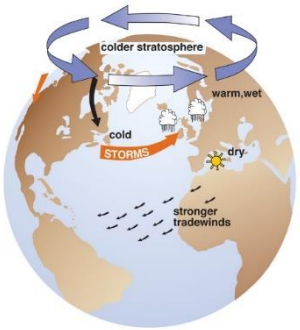
Source: NSIDC.

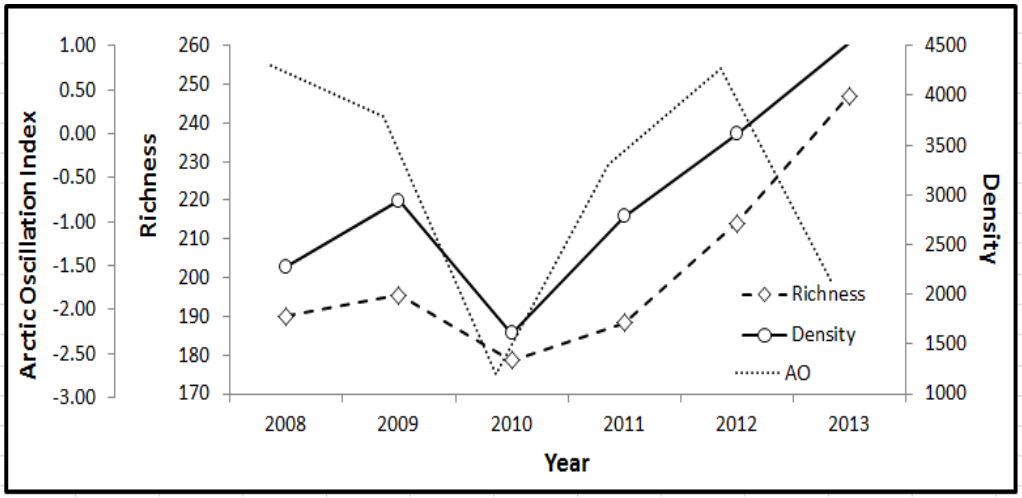


Source: Morison et al., 2012. Nature.

Temporal changes in Arctic biodiversity

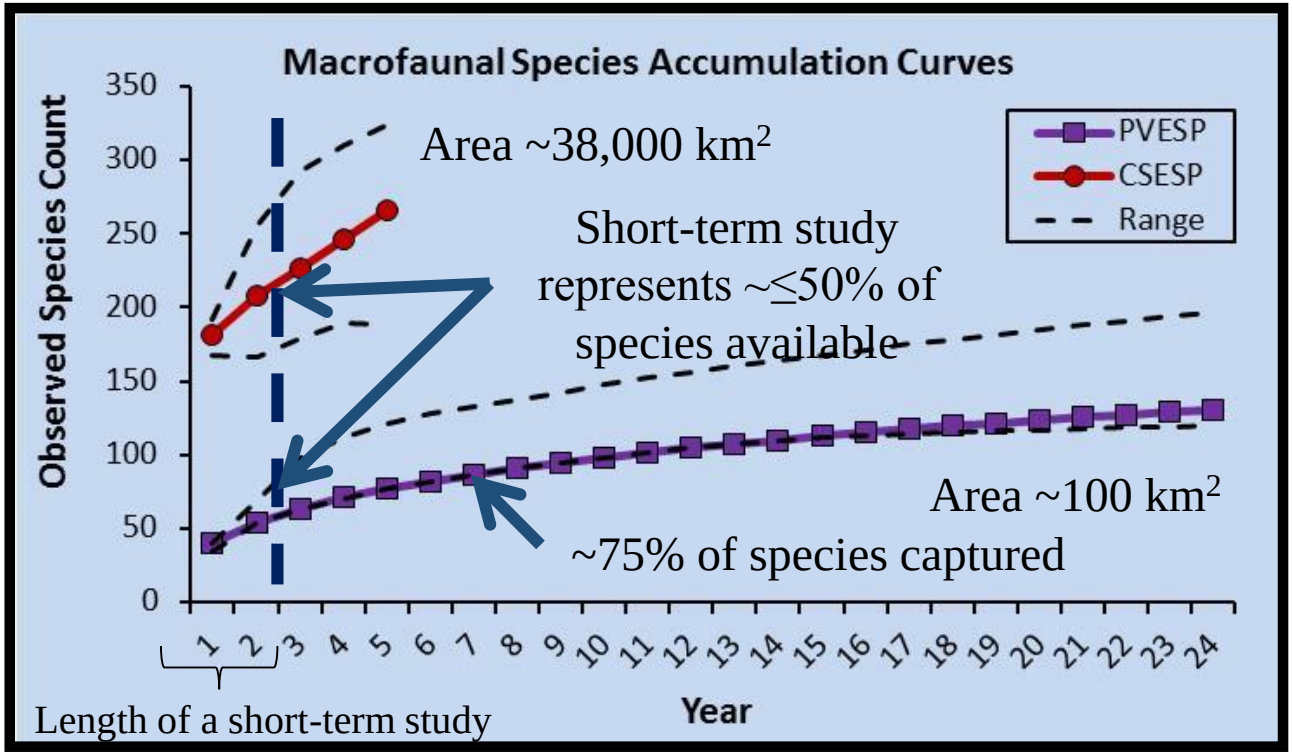
- Strong association between Chukchi Sea subtidal benthic macrofaunal abundance and the Arctic Oscillation (AO; an index of Arctic Ocean sea-level pressure).





Measured biodiversity

>10 years sampling needed to document richness at small (PVESP) and mid-scale (CSESP) extents.



Take home message

- Repeated sampling of sites within homogenous systems requires >10 years to begin to understand richness or measured biodiversity.
- Conclusions of biodiversity confounded in short term studies due to temporal variability.
- Temporal drivers must be considered!
  - Might sample at a “peak” or “valley” of an alternate state.